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EDITORIAL

We are pleased to present to the readers of Management Quarterly an entirely new sampling of academic papers written by students at the Naval Postgraduate School. The papers were selected for their excellence in terms of broad-based appeal, readability, and informative value.

The editorial staff wishes to express its appreciation to the faculty for their cooperation and assistance in identifying papers worthy of publication.

We wish to especially thank Dr. John D. Senger whose active support of this publication is reflected in the volume and quality of papers he has continued to recommend.

In a slight departure from traditional editorials of Management Quarterly, the editors wish to exercise editorial license to provide a thank you to a small group of people who provide excellent support, not only to Management Quarterly, but to the entire Administrative Science student body. These folks smooth the paths of students and lighten their workload by coping with the myriad of administrative and clerical pedantics required of military students in an academic environment. They provide support to the student who has a specific problem in an expeditious and low-key manner without creating additional stress, and always in a friendly manner. For their exceptionally excellent support, and management example, we wish to express our thanks to those persons in the Administrative Sciences Curricular Office.

Succeeding editorial staffs will continue to consider all student papers submitted from every education and research department of the Naval Postgraduate School. This policy provides an opportunity for the broad spectrum of efforts at the school to be recognized and shared by an expanded audience of the future leaders of the U.S. Navy.

Papers for publication may be submitted to Management Quarterly at any time. Suitable papers, research work, and term project reports can be submitted by either delivering them to a member of the editorial staff, or by mailing them to Management Quarterly, Student Mail Center (SMC) Box 1499, Naval Postgraduate School. We believe this journal provides a unique opportunity for students to have their research or academic efforts recognized. We encourage those who feel that their recent academic efforts might be of interest to others to forward a copy to SMC-1499.

Lt. Russell L. Cain, MSC, USN

Lt. Richard Blanchette, MSC, USN

Editors

The views expressed in the MANAGEMENT QUARTERLY are those of the authors exclusively, and in no way reflect the attitude or endorsement of the Department of Defense, the Navy Department, or the Naval Postgraduate School.

Corporate Social Responsibility

by

Captain P. A. GIDO, USMC

ABSTRACT

This paper presents the question of social responsibility from various perspectives. Starting with an overview of social responsibility development in America, the author presents various historical definitions of the term along with some differing perceptions of where the responsibility rests. He then reviews the concept of social responsibility from the perspectives of potential long term economic profit of business organizations along with the social pressure exerted on businesses by society.

This paper was submitted to Professor John D. Senger in partial fulfillment of the course requirements for MN 3105, Organizational Systems II.

Captain Paul A. Gido, USMC, received his Bachelor of Science Degree in Business Administration from Villanova University in May 1972. He is presently a candidate for a Master of Science Degree in Defense Systems Analysis at the Naval Postgraduate School.

The Challenge

In less than three hundred years enterprising men transformed the virgin forest land of the North American continent into the most technologically advanced and industrialized nation in the world. This nation was built by men who possessed a strong work ethic and a desire to improve the society in which they labored. The nation became a melting pot of people, ideals, and dreams. Throughout the nation's history men have been able to assemble resources to overcome problems that at the time seemed insurmountable. Who were the men that built this nation? They were farmers, laborers, businessmen, philosophers, soldiers, and government leaders. Individuals from all walks of life working together built this nation. The society of today is radically different from the society that the forefathers of this nation knew during their lifetime.

The industrialization of the nation advanced society by a quantum leap in a very short time span, but it also created new problems for society. Today our nation is confronted with a large array of major problems. These include nuclear proliferation, shrinking energy supplies, pollution, chemical waste disposal, unemployment, decaying cities, lack of adequate mass transit, high inflation rates, and a myriad of others. Some of these problems have roots spanning generations, others such as nuclear proliferation are relatively new.

Traditionally our society has looked to government (be it Federal, State or Local) to provide the leadership and resources

to solve the major problems of the time. Our society has tended to overlook the contribution of private enterprises and individual voluntary leadership. Government has no magical powers, it draws resources and leadership from the private sector, organizes them into a program (solution) and directs that program at a specific problem. From the long list of problems that confront our society, it has become obvious that government alone cannot solve all these problems. During the late 1970's, the growing disenchantment with government and the growing disbelief in government's ability to solve major social problems, began to cause a grass roots reaction in American Society.

The current Federal administration believes that some of the problems facing our nation can be more effectively resolved by the private sector. The private sector is being called upon to directly participate in the solution of social problems. Business is being asked to increase its contritution toward social goals. Is the private sector really willing to participate in the solution of social problems?

The purpose of this paper is to present the concepts of corporate social responsibility. Various definitions of corporate social responsibility will be examined and the major arguments for and against business participation in the solution of social problems will be presented. This paper approaches social responsibility from a conceptual viewpoint.

Definitions of Social Responsibility

"What is social responsibility?" and "What corporate behavior does the public really expect of the corporation?" are seldom answered questions. "The very term 'social responsibility' is so vague and indeterminate that many economists and businessmen are reluctant to use it for fear of having to define it." (McGuire, 615) Business enterprise was once only expected to devote its effort to producing and distributing goods and services as efficiently as possible. Today the business community is expected to promote a variety of social causes in addition to their economic purpose. "The demands for 'social responsibility' have provoked extensive discussion and debate on what roles, if any, business firms should play in the social system. The novelty and variety of these demands have raised profound questions about the extent to which it is possible or desireable to vest in the business firm the duty to cure social ills." (McKie, VII) The social responsibility of business is still a very controversial subject.

The discussion of corporate social responsibility in chapter 3, Management, did not provide an adequate definition of the term, 'social responsibility'. Stoner's presentation of the "Concepts of Organization or Corporate Responsibility" is mainly drawn from Chapter 19 of McGuire's, Contemporary Management. McGuire's book published in 1974 is a collection of essays. The contributors to the section on corporate social responsibility include R. J. Monsen, Keith Davis, and C. C. Watton. These articles served as the starting

point for research into the topic of social responsibility.

Monsen defines social responsibility in terms of public expectations. (McGuire, 617) He introduces the concept that business must gauge public opinion regarding business behavior and pursue business policies which meet the public expectations. If business is interpreting the public expectations correctly and reacting accordingly then business is being socially responsible. The article written in 1971, states that no definition of social responsibility has gained a general acceptance. All of the various definitions of social responsibility imply certain "levels of activism" and should be explained in that light. (McGuire, 617) Monsen acknowledges that defining social responsibility in terms of public expectations is a simple approach which does not consider the corporate leadership or influence in molding public opinion. (McGuire, 617)

Davis presented, in my opinion, the best definition of social responsibility: "one definition arises from the fact that business is part of a complex and interdependent social system in which business actions influence other parts of the system. It follows that a responsible businessman, and indeed a responsible member of any other type organization, must act with due concern for the effects of his decision on the system. Social responsibility, therefore, refers to a person's obligation to evaluate in the decision making process the effects of both his personal and institutional decisions on the whole social system. The substance of social responsibility arises from concern for the ethical consequences of one's acts as they might affect the interest of others...Social

responsibility moves one large step farther by including institutional actions and their effect on the whole social system." (McGuire, 629)

Davis' definition requires a businessman to consider his actions in terms of the whole social system and holds him responsible for the effects of his acts anywhere in the system. The organization must take into account the external environment.

The socially responsible organization is one which realizes that its decisions affect the welfare of other people and takes the time to find out how , and to what extent they will be affected. "With the recognition that a business organization is part of a wider society, its activities must be judged against the standard implicit in the wider society. Although in legal terms, the responsibility for corporate decisions may be attributed to a legal fiction 'corporate person'; in moral terms, the responsibility for corporate decisions rests on the individual members of the corporation." (Atkinson, 131) This contemporary view published last year underscores the fact that the decisions of business organizations will be judged by the ever changing moral standards of society.

The standards of a society are represented by its general morality and codified laws. Davis' broad definition of social responsibility considers the whole system. "Defined in this way, social responsibility is something more than mere compliance with the law, because not all system effects of business decisions are covered by law, it is unlikely that they ever can be." (McGuire, 630) Social responsibility involves a recognition of codified law.

"Social responsibility has been defined as the incident when a corporation volunteers to expend its resources to do something not required by law and without immediate economic benefits." (Moskal, 54)

In discussing Monsen's theory of public expectations, Davis argues that "social responsibility is more than an intelligent anticipation of future public expectations". (mcGuire, 630) He views the businessman as an active participant, rather than a passive respondent. In other words, the businessman should offer leadership in social areas rather than merely responding to perceived public expectations. He should contribute his expertise to assist the entire society in attaining social goals.

The exact definition of social responsibility will continue to be debated by scholars and businessmen. Its meaning will change as society's view toward business changes. The important point is that every business must decide what its social responsibilities are. This decision cannot be made without a basic understanding of the term "social responsibility". Based on the concepts that have been presented each individual business defines social responsibility in some context.

Opposing Views

Stoner's discussion of corporate social responsibility focuses on two opposing views of the proper role of business in our society. (Stoner, 76) One view follows classical economic theory. Its contention is that the social responsibility of a business enterprise is solely to maximize profits. The other view contends that a

business needs to acknowledge a variety of social purposes in addition to its long standing economic objective. This view holds that active involvement in the solution of social problems is a proper role for business.

Classical economic theory can be traced to Adam Smith. His book, The Wealth of Nations (1776) is generally regarded as the "germinal book on the subject of economics". (Samuelson, 41) Adam Smith proposed the theory of the "Invisible Hand". Its implications were expressed in the following famous passage:

> "Every individual necessarily labours to render the annual revenue of the society as great as he can. He generally indeed, neither intends to promote the public interest, nor knows how much he is promoting it...By directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."

The classical view which evolved from Smith's ideas can be simplified into three major points. They are:

1. Economic behavior is separate and distinct from other types of behavior, and business organizations are distinct from other organizations, even though the same individuals may be involved in business and nonbusiness affairs.

2. The primary criteria of business performance are economic efficiency and growth in production of goods and services, including improvements in technology and innovations in goods and services.

3. The primary goal and motivating force for business organizations is profit. Profits are kept to reasonable levels by

market competition, which leads the firm pursuing its own self-interests to an end that is no part of its conscious intention: enhancement of the public welfare. It need not recognize any responsibility to the public to accomplish this result. (McKie, 19)

A contemporary version of the classical theory was expressed by Milton Friedman in Capitalism and Freedom. Stoner identifies Friedman as the "most prestigious exponenet" of the classical view. The major arguments against any expansion of the classical view of social responsibility are summarized in Appendix 1. The arguments which have the greatest validity are: the cost of social responsibility and the lack of accountability to the public.

The consumer must ultimately bear the cost of a firm's involvement in social programs. It can also be argued that the consumer bears the cost of a firm's noninvolvement in the solution of social problems. The consumer has a very limited capability to influence social projects sponsored by business. A business is accountable to its owners and stockholders for its actions. In the book, The New Industrial State, J. K. Galbraith expressed skepticism about managerial responsibility and the suitability of private business corporations as agencies for realizing social goals. In Galbraith's opinion, large corporations must come under much more comprehensive social control before they can meet social needs.

Many firms have been impugned for adhering to the classical theory. Business has been widely criticized, sometimes from within its own ranks, for failing to respond in more enlightened and generous terms to the full range of needs of the society from which it draws its wealth. Critics of business have pointed

to many instances of neglect of, or insensitivity to, considerations other than those offering short term private advantage." (Heald, 7) Business must be concerned with growth and survival over the long run. A business policy which is based solely on maximizing profits and ignores all other social responsibilities seems doomed to failure in the long run because today's society expects more of business.

Expanded Social Role

The opposing view to the classical economic theory sees a more active involvement of business in the solution of social problems. "Managements of all institutions are responsible for their by-products, ths is, the impacts of their legitimate activities on people and on the physical and social environment. They are increasingly expected to anticipate and resolve social problems." (Drucker, 312)

Robert Owen is generally singled out as the first to expand the role of business from profit maximization to active participation in the solution of social problems. "Owen recognized the employer's stake in the health and well-being of his workers and the manufacturer's interest in adequate wages for the laborer. Humane conditions within the factory, decent circumstances of housing and living, provision for the education of the community's children, all in Owen's vision, were woven into the seamless web of a healthy and productive society. All his own experience seemed to offer proof that concern for the interests of the

workers was profitable, as well as charitable." (Heald, 4) The social responsibilities of business have been discussed sinced Owen's time. A discussion of social responsibility can be found in almost any text on general management.

The earlier discussions of social responsibility centered in three areas. One was the question of the relationship between private ethics and public ethics. The second was the social responsibility which the employer bears toward his employees by virtue of his power and wealth. The third area was the leadership responsibility of the businessman with respect to the "culture of the community", philanthrophy and willingness to serve in government. (Drucker, 313)

When the social responsibilities are discussed today, the emphasis is very different. The emphasis is on what business should do to tackle and solve the problems of society. These problems range from racial discrimination to preservation of the environment. "More than ever, companies are under pressure by shareholders, consumer groups and government agencies to engage in socially responsible activities." (Cowen, 10)

The major arguments for social responsibility are summarized in Appendix 2. Davis' "Iron Law of Responsibility" is referred to in the summary and deserves special attention. The Iron Law of Responsibility states, "that in the long run those who do not use power in a manner that society considers responsible will tend to lose it." (McGuire, 630) "The law's application to man's institutions certainly stands confirmed by history. Although the 'long run' may require decades and even centuries

in some instances, society ultimately acts to reduce power when it is not used responsibly." (McGuire, 630)

"We are entering an era where corporations will be subject to greater public scrutiny than they have ever known, where the public may well insist that they establish their very right to exist." (Daprix, 692) A business is only part of a larger external environment. It must be able to interact with the external environment if it is to prosper. "The reality is blunt and conclusive. Society is dependent on business. Business is dependent on society. The corporation cannot realistically or rationally divorce itself from society's covenants. Socially constructive corporate action will in the long run benefit all of society. Irresponsible action or inaction will boomerang to harm business as well as the nonbusiness sector." (Linowes, 4)

"Government" and "Big Business" are regarded as the two dominant organizations in American society. The current adminstration desires to enlist the aid of "Big Business" in solving social problems. Is "Big Business" willing to accept the challenge? What are the limits of corporate social responsibility?

Limits of Corporate Responsibility

"It is the success of the business system which leads to new, and in many cases, exaggerated expectations. The demand for social responsibility is, in large measure, the price of success." (Drucker, 316) Today's businessmen and social planners

disagree sharply over the parameters of social responsibility. The problem of identifying social responsibilities is aggravated by:

1. The fact that public expectations of business are constantly changing, and
2. respective social roles of business and government are becoming less distinct. (Strier, 119-121)

It is even more difficult to identify the responsibilities of any given firm. Few social and political guidelines for acceptable social action exist. How can management identify the social responsibilities of the firm?

Managements' first step should be to conduct a review of presently-held social values. This should be a critical self examination. It must begin at the highest levels of the firm. The social values of top management must be shared with key personnel at the operating level of the firm. Members of a corporation must know where top management stands in relation to social responsibilities. The management must establish specific social goals and a policy to attain those goals. "The firms social responsibilities can be further identified through the use of: 1. categorization; 2. internal social audits; 3. forecasting; 4. management re-education programs; 5. joint conferences; and 6. constituent groups represented by public board members." (Strier, 126) Once a corporation identifies and acknowledges social responsibilites, it must then decide how to respond.

A corporation can exercise its social responsibility in various ways. It can lend some of its personnel to serve on community projects, finance the training of unskilled personnel, contract with minority businesses even when its needs could be met elsewhere, or perhaps improve the environment surrounding its facilities. There is an endless list of ways for business to participate in the solution of social problems. Perhaps an innovative approach from the private sector will provide the insight to a problem that defies the solutions that government has employed in the past.

However, before a business can exercise its social responsibilities in any manner, it must show a profit and maintain a rate of growth. (Chamberlain, 6) It is doubtful that a business will voluntarily undertake actions that are not in the best interests of its owners, managers, and workers. Nor will it participate in clearly unprofitable ventures for any length of time.

The proper role of business in pursuing social responsibilities lies somewhere between the two opposing views of profit maximization and all out involvement in solving social problems. This is not a fence stradling cop out. It is a realization that business can assist in the solution of some social problems, but its involvement is limited by economic reality.

A study group on business social responsibility sponsored by the Committee for Economic Development (CED) has expressed the essence of this limited responsibility very nicely:

> "Corporations are necessarily limited by various internal constraints on what and how much they can do to improve society ...Cost benefit considerations are a very important factor. No company of any size can willingly incur costs which would jeopardize its competitive position and threaten its survival. ...This means that substantial investments in social improvements will have to contribute to earnings, and the extent of such earnings will be a major factor in determining the mix of a company's commercial and social activities." (CED, 32-33)

Since "Big Business" is a dominant force in our society, it has in many respects an obligation to the greater society of which it is a part. Society and business are interdependent. "Big Business" cannot afford to completely divorce itself from its social obligations. The Iron Law of Responsibility demands that successful organizations recognize their responsibility to the entire society or face censure by the society. The demand for business to engage in socially responsible activities is increasing. Business can make important contributions toward the advancement of our society. "The voluntary sector is today more critical to America than ever before because the nation's international and domestic needs are growing daily, and people are beginning to realize that national resources are finite and that government cannot solve every social ill." (Dayton, 19)

Corporate social responsibility exists in our society and can be defined as the moral and ethical values which influence corporate decision making. Corporations are increasing their involvement in socially oriented activities in order to meet public expectations. However there are limits to corporate social responsibility. Economic reality demands reasonable profit and growth. Society acknowledges these as valid economic objectives. Additionally, society expects business to contribute leadership and resources to the solution of social problems. The proper role of business must be social as well as economic.

Appendix 1

Major arguments against the expansion of Social Responsibility:

1. Violates profit maximization.
2. Cost of social responsibility is too great and would increase prices too much.
3. Business lacks the social skills needed to solve social problems.
4. It would dilute the primary purpose of business.
5. Business lacks accountability to the public. Thus the public would have no control over its social involvement.
6. Such business involvement lacks broad public support.
7. Business already has too much power. Such involvement would make business too powerful.
8. It would weaken the U.S. balance of payments because the price of goods will have to be increased to pay for social programs.

Extracted from chapter 19 of McGuire's Contemporary Management.

Appendix 2

Major arguments for the expansion of Social Responsibility:

1. It is in the long run self-interest of the firm to promote and improve the communities where it does business.
2. It improves the public image of the firm.
3. It increases the viability of the business system. Business exists because it gives society benefits. Society can amend or take away its charter. This is the "Iron Law of Responsibility".
4. It is necessary to avoid increased government regulation.
5. Society expects it. Socio-cultural norms require it.
6. Codified law does not cover all circumstances, business must assume responsibility to maintain an orderly legal society.
7. It is in the owners (stockholders) best interest. The stock market will view the firm as less risky and open to public attack.
8. Society should give business a chance to solve social problems that government has failed to solve.
9. Business has the human and financial resources to solve social problems.
10. Problems can become profitable.
11. Let business attempt to solve problems before they become too great.

Extracted from Chapter 19 of McGuire's Contemporary Management.

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Technology Transfer: What is it? What can it do for me?

by

LIEUTENANT COMMANDER GARY W. STRAWN, USN

ABSTRACT

This article presents a personal and rather humourous examination of the relatively new concept of technology transfer. The author provides succinct views of the subject from research, management, and public sector perspectives. He then explores the legal issues and the impact of the options an inventor in the U. S. confronts in implementing new technology. The author posits that the technological implementation gap is greatest in the international setting and provides an interesting example of technological modification required to capitalize on excess labor in less developed countries. Lcdr. Strawn concludes that technology transfer abounds everywhere, and the more we recognize it in our daily lives, the more effectively we can implement it and increase our industrial productivity.

This paper was submitted to Professor John D. Senger in partial fulfillment of the course requirements for MN 3105, Organizational Systems II.

Lieutenant Commander Strawn, USN, received his Bachelor of Arts Degree in Social Science from San Jose State in 1968. He is presently a candidate for the Master of Science Degree in Material Management at the Naval Postgraduate School.

INTRODUCTION

If the essence of the scientific method is objectivity, and if objectivity is defined as the absence, or at least, the control of preconceptions and prejudices, then I have a distinct advantage. Not only do I not have any preconceptions about the subject of Technical Transfer, I don't even know what it is. Oh, I have heard the words, and as a student working towards a Master of Science Degree in Material Management, I have even tried to nod intelligently when a professor used them. Although I would be the last to claim any understanding of the subject. I am interested in learning about any applications the study of Technology Transfer may have in my business, aviation maintenance.

The purpose of this paper then, is the synthesis of current professional and academic literature on the subject of technical transfer, in order to determine what it is all about, and what useful application I might make of this body of knowledge.

TECHNICAL TRANSFER: A DEFINITION OR SIX

A logical place to begin would seem to be with a definition. Professor Creighton defines Technology Transfer as "a purposive conscious effort to move technical devises, materials, methods, and/or information from the point of discovery or development to new users." (Creighton 1972) Alternately, it has been described as "a human characteristic", "the selling of licenses", "the moving of a number of processes based on scientific knowledge from one person or group of persons to another", or that which "takes place when a group of people, usually belonging to one body, become capable of performing one or several functions attached to a specific technique in satisfactory conditions". (Seurat 1979)

Another author defines it as the "processes whereby research knowledge is transferred operationally into useful processes, products or programs that fulfill actual or potential public or private needs". (Linhares 1976) The United States Senate Subcommittee on Science and Technology in its Report on Policy and Planning for Technology Transfer of 6 April 1967, gave the following definition. Technology Transfer is the "process of matching solutions in the form of existing science and engineering knowledge to problems in commerce or public programs". (Strasser 1974)

The dictionary definition of technology is "the science of the application of knowledge to particular purposes", and "the total means of a people to provide itself with the objects of its material culture". Transfer is defined as the conveyance as with a title, a change in ownership, or as is done with an image or picture which is impsoed from one medium to another. (Websters 1961)

It is not my intention to select any definition as being more accurate than the others or to ridicule the wide variance of perceived meanings. Rather, I am struck with the fact that this topic covers a wide spectrum of applications and the variety of definitions merely reflects the variety of backgrounds and interest areas of the authors. Research and Development people see technology transfer as a means by which their product is sold or distributed to the users: the production or operations departments. Corporate legal departments and governement bureaucrats see it as proprietary problems surrounded by legal rights such as patents and contracts. Industrial entrepreneurs see it as the vehicle for economic growth and the capitalistic method by which inovation is utilized to fill society's needs. Legislators and government leaders see it as a problem of utilizing the huge government technical data banks to enhance the economy and public welfare as a whole.

World leaders and students of international relations view technology transfer as the means by which the underdeveloped countries can benefit from the industrial and scientific advances of the modern world and thereby be brought into the mainstream of the world's economy.

For the sake of organization, I will approach the subject matter from each of these varying view points.

TECHNOLOGY TRANSFER FROM DIFFERENT PERSPECTIVES

AN R & D VIEWPOINT

Here is a group with vested interests in the topic if there ever was one. Technology, and the advancement of it, is the reasearcher's livelihood. They may be considered the "pushers" of technology. They are the broadcasters, but at least some of them feel that their broadcasts are not being picked up by a sufficient number of turned on receivers. In his article on this subject, the head of the Naval Facilities Engineering Command (NAVFAC) R&D Department, states his belief that the R&D community has reached a point of diminishing returns with respect to pushing technology. "Only top management can make the necessary changes to ensure adequate reception of the technology being broadcast." He concludes that top management is predisposed to the obtainment of concrete goals with limited budgets, and has little remaining energy for the promotion of long range abstract concepts such as Technology Transfer. He recommends, in typical R&D fashion, a serious research effort into the factors which might improve the reception end of the technology transfer process. (essoglou 1980) A technology for Technology Transfer?

MANAGEMENT'S VIEWPOINT

Top management is confronted by Technology Transfer in a number of ways. If it is a large enough organization to have an R&D division, then a positive

environment which encourages the utilization of the R&D product by the other components (pull), is necessary if the R&D is to be worthwhile. Without a specialized R&D section, the new ideas or innovations may come from within the corporation as suggestions from employees or consultants. It can also come from external sources such as other corporations, universities, research organizations or government agencies. Examples of these four sources of commercial technology transfer may serve to demonstrate the critical importance of technology transfer in successful corporate management.

An excellent example of successful corporation to corporation technology transfer was the entrance of Texas Instruments (TI) into the transistor business in the early 1950's. Prior to 1952, TI was a small instrument company with no experience in semiconductors. In the spring of 1952, after attending a Bell Systems symposium on semiconductors, TI commenced engineering and research work. Aided by the defection of a Key Bell researcher and the support of the head of Bell's semiconductor development effort, TI became the world's leader in semiconductor capability by 1953. The resultant sales from this technology was estimated at $750 million in 1971. (White 1974)

An example of government to corporation technology transfer is the development of the commerical jet airliner by Boeing from Air Force bomber technology. At the time, the airlines were not receptive to jet technology, but Boeing's president, in a stint of entrepreneurial perseverance between 1951 and 1953, convinced the Air Force of the worth of a jet tanker/transport by building a prototype 707/KC-135 at $15 million of company expense. The Air Force made its initial order for KC-135's in 1954, and Pan American followed a year later with commercial orders. It was entrepreneurial effort by Boeing which took a company whose major livelihood had been in producing Air Force bombers and built that technology base into the world's leader

in commercial transports. It took years for the competition, Douglas, to come on line with the DC-10 which imitated the 707's technology, and Lockheed has never regained its previous status held by the reciprocating engined Constellation. (White 1974)

Battelle Institute procured and developed xerographic technology in the late 1940's. Through entreprenurial initiatives on the part of management, both of Battelle and Haloid Corporation (later Haloid Xerox), an agreement to commercially develop and market the Xerox copier resulted in a $2 billion industry by 1971. It took a combination of the technology of Battelle and an $87.6 million industrial commitment, operating at a $44.5 million loss over seven years, by Haloid to produce the success. (White 1974)

Finally, an example of university to corporation technology transfer is the development of the electronic computer by Remington Rand, with technology developed by the University of Pennsylvania for the Army Ordnance, Ballistics Research Laboratory in 1946. The university researchers started a computer corporation and developed the UNIVAC in 1951. Remington Rand bought them out, and with the additional capital committment ($12 million), the first machine was sold to the Government Census Bureau in 1952. Late that year the machine predicted the outcome of the Eisenhower election, and the computer age was off and running. Univac led the industry through the mid 1950's. Computer sales exceeded $9.6 billion by 1971. (White 1974)

It may only be a coincidence, but it seems strange that all of these examples of Technology Transfer which led to major changes in our society as well as returning healthy profits to the entrepreneurs who supported them, occurred 25 to 30 years ago. This may be a result of the reduction in government R&D funding from

two percent of the Gross National Product in 1970 to one percent in 1977 or it may be a function of the lack of turned on receivers as discussed by Linhares. In any case, encouragement, if not outright exploitation of innovation has been the basis of success of the traditional American Entrepreneur.

TECHNOLOGY TRANSFER IN THE PUBLIC SECTOR

The federal budger for research and development was approximately $22 billion in 1976 (Federal R&D Program FY76); $2.9 billion for space, $11.4 billion for defense, and $7.4 billion in FY81. (Dept. of Commerce 1981) It has been estimated that over half of the civilian R&D efforts were for the eventual benefit of private industry or state and local governments. (Linhares 1976) Therefore, the vertical transfer of this knowledge is fundamental to the successful accomplishment of the mission. In the larger case of the defense and space, R&D efforts are primarily for in-house consumption. The transfer of their developed technologies horizontally within the organizations is necessary for the accomplishment of their goals. However, in a greater sense, the purpose of all government research is to benefit the public who is paying the bill. The spin-off or secondary benefits of all government research can be considerable. Velcro, Tang, and the semiconductor electronics industry are all examples of the secondary benefits of space technology.

The Naval Material Systems Command (NAVMAT) currently has a technology data bank valued in excess of $700 million. (Grosson 1981) With new Department of Defense (DoD) initiatives to lower material acquisition costs, improve the effectiveness of our

military hardware, enhance the commercial industrial base of the nation, and remove the barriers or adversary roles which have developed between government and industry (DEPSECDEF 1981) there is now a major push within NAVMAT to enhance the transfer of their technology base. The data base comes from three basic sources: publicly owned research centers such as the Naval Research Laboratory, publicly funded research performed by civilian institutions, or proprietary technical information retained from the research and engineering efforts of the contractors in the process of developing Naval weapons systems. (Grosson 1981) In any case, whether the technology was gained by pure research, or as a spin-off from some systems development, much of this data can have applications to other Navy, DoD, Federal or local government, or civilian organizations.

The leaders of our government are concerned that the public is not getting the full benefit of the technical and scientific knowledge which they pay for, but the problems in making this happen are two-fold. The government technical community must be made aware of the needs and desires of the potential users so that research can be directed towards these needs and/or the resulting data presented or made available in a useful form. Secondly, the potential users must be given the tools whereby they can access or query both the existing data and those directing current or future research. (Linhares 1976)

Congress is also quite interested in enhancing the utilization of the vast amounts of technology owned or obtained by the government. Beginning with the Civilian Industrial Technology Program (1963),

and the Office of State Technical Services in the Department of Commerce (1965), Congress appropriated money to enhance the utilization and intergovernment transfer of technology. Throughout the late sixties and seventies, six bills dealing with technology transfer and utilization of government held scientific data were considered by congress. Specific failures were a result of the complexities of legislating such efforts and not to be interpreted as any lack of concern for the problem. (Underwood 1977)

The National Science and Technology Policy, Organization, and Priorities Act of 1976 established the Office of Science and Technology (OSTP), and the Office of Intergovernmental Science and Publich Technology within the National Science Foundation, and set national priorities for the furtherance of Technology Transfer throughout both the public and private sectors. (Linhares 1976)

Specifically, the Office of Intergovernmental Programs has established a series of networks of potential users of the public technology base. Based on geographic divisions, these "innovation groups" consist of interested personnel from various public sector organizations who work together to identify problems and screen sources of science and technology for solutions and applicable techniques.

The more recent policy directives emanating from the Reagan Administration are providing increased impetus for technology transfer efforts. (Grosson 1981)

THE LEGALITIES OF TECHNOLOGY TRANSFER

In the four examples used previously in the section on management's perspective, the huge financial gains were relatively unencumbered by legalistic claims and patents. This has been attributed to thefact that in two of the cases, Boeing and Univac, much of the initial technology was under government contracts. In the case of TI, Bell actively pursued developers for its patented semiconductor technology. Only in the Battelle/Haloid transfer was there a significant sharing of the profits. (White 1974) The fact remains, however, that technology is a valuable asset which deserves to be protected as well as exploited. In a larger sense it can be argued that while the inventors or owners of a technology deserve some remuneration, society as a whole, deserves to benefit from the fruits of its culture. Seurat 1979) There are four options open to an inventor in the United States today. He may opt for total secrecy and suppress the new technology for fear of upsetting the status quo. He may attempt to develop the technology while keeping it secret within the company. An example of this approach might be an innovation in production line machinery which could be easily kept secret whereas infringement on patent right, if that option was selected, would be nearly impossible to prove. The patent option provides limited monopoly rights for seventeen years, but can require expensive legalistic enforcement. The other option is full disclosure which gives up all direct financial claims, but may bring secondary benefits in the form of advertising and a corporate image of industry leadership. (Elsasser 1977)

Within the public sector, proprietary rights may be written into contracts for a variety of reasons. NAVMAT has traditionally used this method to avoid being locked into one supplier for a commodity or weapons system. If the contractor defaults or cannot meet follow-on requirements, ownership of the technology base will allow NAVMAT to bring new contractors into the field. It can also provide insurance against excessive price increases for follow-on support or additional applications. Such policies have led to a proliferation in the government's data base. It can be argued that such a policy adds excessively to the cost of the contracts and has a secondary effect of stifling incentives for further developments. (Grosson 1981) Under the Reagan Administration, there is a push within DoD to reduce the use of proprietary rights in hardware and software contracts and thereby increase the incentives for Defense contractors and to expand the industrial base. (DEPSECDEF 1981)

SOME RAMIFICATIONS OF INTERNATIONAL TECHNOLOGY TRANSFER

A nation wide survey of universities and colleges found that only twenty offered courses pertaining to Technology Transfer. The courses were offered by a variety of academic departments ranging from Psychology and Sociology through Business Administration, Agriculture, Engineering, Journalism, and Political Science. A common thread through eighty percent of the courses was a concentration on the international perspective. (Schuelke, et al. 1978) This predominance of interest does not seem to be reflected in the quantities of literature available, but suffice it to say that International Technology Transfer is a significant

portion of the overall topic. The disparity in technological development between nations and the important role technology plays in international relations have been stated as reasons for the academic interest in the topic. The desire for the transfer of modern technology to underdeveloped countries is shared by both government and private interests, but are fraught with complications. Fears of disruption of the social or economic structure of a developing country , or exploitation of its natural resources by the superpowers are widely publicized, but a desire for the increased productivity and material wealth seem to be overpowering. (Seurat 1979)

The central problem revolves around the selection of the proper types of technology. Purely economic decisions based on capital investment and return have met with repeated failures in international technological development ventures. (Strasser 1974) Improved methods for determining theproper level and types of technology to fit the developing nation's cultural and social needs have been developed, and are being promoted by the U. S. Agency for International Development (AID), and the United Nations. Of primary importance is the adaptation of industrial technology to allow for maximum labor intensity and minimum capital investment. For example, a food canning plant might be converted from a continuous to a batch processing which requires more labor, less capital, and produces at a lower per unit cost. The concept of the "industrial profile" was developed by SRI economist E. A. Staley to describe the pertinent aspects of industrial plants and aid in the selection of the

proper types of industrial development to fit indigenous economic and social factors. (Bredo 1974) It is the selection and adaptation of technology, not just the imposition of it, which determines the success of international technology transfer. There are many related factors such as national security, arms proliferation, "human rights", and balance of payments which complicate the issues. (Bredo 1974 and Seurat 1979) In a significant way these concerns act as a reverse technology transfer. As we push industrial technology to the "underveloped" nations, we receive in return vast amounts of new knowledge and understanding of differing cultures, and are forced to develop new management techniques.

CONCLUSIONS

I find that I did have a seemingly common preconception about the term technology transfer, at least about the technology part. Like many of the managers discussed in the literature, I think of technology in terms of scientific data being applied to the production of goods. Returning to definitions for a moment, the root of technology, "technique" has two definitions. The first is "a number of processes based on scientific know-how used in production", and a second broader one is "a number of procedures used to produce something, or to obtain a previously determined result". (Seurat 1979) Utilizing the second definition, I can broaden my view of technology transfer, particularly as it pertains to management, to include innovations in such fields as sales, advertising, marketing, accounting, and even management itself.

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Patents and the Procurement Process

by

Lieutenant P. J. Flanagan, SC, USN

ABSTRACT

When awarding government contracts the principal contracting officer is protected against patent infringement by various statutes and contract clauses which allow him to award contracts even though it may be known that a patent owners rights are being violated. In this article, Lt. Flanagan examines the government's patent policy, and the impact that this policy has on contracting officers, business firms awarded government contracts, and on patent owners. Based on an examination made of claims procedures and on reimbursements made for patent claims, the author concludes that the government's patent policy with respect to unauthorized use of a patent by the government is fair and equitable and protects the rights of both the government and the patent owner.

This paper was submitted to Professor David V. Lamm, Cdr., SC, USN, in partial fulfillment of the course requirements for Contracts Pricing and Negotiation, MN 3304.

Lt. Patrick J. Flanagan, SC, USN, received his Bachelor of Science Degree in Economics from the University of Scranton in 1972. He was awarded the Master of Science Degree in Acquisition and Contract Management at the Naval Postgraduate School in March 1981.

I have some problems accepting the "transfer" side of the term as being adequately descriptive. Perhaps something like "Technology Transfer, Application and/or Utilization", would better cover the broad range of activities being discussed. I don't want to get hung up on definitions because only half of my topic was concerned with "what is it ", the other half was "what can it do for me?". I realize now that I have just been the benefactor of a technology transfer. In the introduction I stated that I wanted to synthesize a data base and determine what it was all about: a transfer of technical knowledge. How I will utilize it other than to finish the requirements of another class remains to be seen.

The body of knowledge is huge. I discussed five viewpoints, only scratching the surface, and I am sure there are many more. The important thing to remember is that we deal with technology transfer every day. I only thought that I didn't know what it was. By giving it a name, accurate or not, we are able to examine it at different angles and realize it as a process which we engage in every day. How well we do it not only determines our industrial productivity, but our social adaptation as well.

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INTRODUCTION

The purpose of this paper is to explore in some detail the area of patents as a factor in the military procurement process. The writer's interest in this subject was aroused, initially at least, by what may best be described as ethical objections to the practice of military agencies in awarding contracts involving intentional or acknowledged infringement of patents issued by the Federal Government. Recognition of this willingness of the Department of Defense contracting officers to authorize, either explicitly or by award of a contract which involves use of a production process patented by a firm other than the recipient of the award, was somewhat startling.

On the surface such activities seem to represent a blatant disregard for the legal rights of patent holders. In the discussion that follows it is hoped that this concept will be replaced by definition of the proper consideration of patent rights (and infringement) in conducting cost and price analysis in military procurements. Background information on the Federal legislation and Department of Defense regulations pertaining to patents will be presented. Recent initiatives in reforming the Government's official patent policy will be examined. Finally, one military procurement agnecy's views regarding claims for patent infringement will be included in the discussion.

PATENT LAWS AND REGULATIONS

A patent is defined as a "grant by the State or Sovereign to a designated person or corporation, of a certain right or privilege". (Biesterfeld 1949) Patents for invention have been granted at various times throughout history by governments and sovereigns. The first system established for the grant of patents in the modern sense was originated in England. In the American colonies, especially in Massachusetts, New Hampshire, and Connecticut, there was some provision for granting patents, with the earliest patent having been granted in 1646. (Biesterfeld 1949)

Incorporated in the framing of the Constitution was a provision authorizing Congress to establish a patent system. Article I, Section 8 reads in part:

> The Congress shall have the power...To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries;...

According to the English Statute of Monopolies, the foundation for the United States Patent Law, the grant of patents for devices deemed to be within public knowledge was forbidden, but with an exception that the bringing into existence of a new invention by a first and true inventor would be recognized by the issuing of a patent. (Biesterfeld 1949) This provision, that new and original inventions were advantageous to the State and its citizens and merited special inducement and reward in the form of a limited monopoly, was the Government's official recognition of the need for patents. The creation of such monopolies was seen as a contribution to the public wealth. The major progress experienced

by both England and the United States during the Industrial Revolution was due in large part to the stimulus provided by a protective patent system. Inventors were encouraged to risk their time and personal wealth in the creation of new machines and products, in hopes of realizing personal reward commensurate with their contribution toward the public welfare.

U. S. Patent Acts

As stated above the U. S. Constitution empowered Congress to secure to inventors the exclusive right to their discoveries and inventions. Pursuant to this power a series of patent acts were passed to provide for the scope of protection envisioned. Congress passed the first patent act in 1790 inaugurating the grant of patents under federal authority.

The present patent act, known as the Patent Act of 1952, Title 35 of the U. S. Code (1964), provides that:

> Every patent shall contain...a grant to the patentee (owner of the patent)...of the right to exclude others from making, using or selling the invention. (Patent Act of 1952, 35 U.S.C. (1964))

The law also provides that:

> ...whoever without authority makes, uses, or sells any patented invention within the United States during the term of the patent therefor, infringes the patent. (Patent Act of 1952, 35 U.S.C. (1964))

Patent infringement, then, may be defined as the unauthorized making, using, or selling of the patented invention, with the wrongdoing carried out by one who violates the patent.

A patent is viewed as having the same attributes as personal property with the patent owner possessing clear property rights in his patent. In addition, patent infringement is described

as the invasion of this property right, and is essentially a tort. In strict statutory terms, within the various classes of invention, a patented process may be infringed only by the practice or carrying out of the claimed steps in the process. On the other hand, machines, articles, and compositions of matter are said to be infringed by making, manufacturing, using or selling the patented item specifically covered. (Peters 1967)

Patents grant to an inventor the right to exclude others from making, using, or selling his invention for a period of seventeen years. The exclusion right extends throughout the United States and its territories. The scope of discussion contained in this paper is concerned only with "utility" patents covering an article or process.

Patent Considerations in Government Contracts

The above discussion provides the legislative background for the government's authority to issue patents. When the situation involves the government as one of the parties in a contract, however, several additional key statutes relating to patents and technical data must also be considered: (Black 1978)

1. Title 10 of the U. S. Code provides:

   a. The U. S. Court of Claims has jurisdiction in suits brought against the United States for patent infringement.

   b. The Department of Defense is authorized to use appropriated funds for the acquisition of copyrights, patents, and applications for patents, for their licensing, or for the settlement of claims of their infringement. (emphasis added)

2. Title 22 of the U. S. Code provides:

   a. The director, United States Arms Control and

Disarmament Agency, can make all patents developed through the use of appropriated funds available to the general public.

b. The Secretaries of individual military agencies must protect the patent rights of all citizens in the sale of surplus material.

3. Title 28 of the U. S. Code provides that the owner of any invention covered by a U. S. patent has the right of reasonable compensation only in an action brought against the U. S. Government in the Court of Claims where the patent has been infringed through the authorization or consent of the Government.

4. Title 42 of the U. S. Code provides that the Secretary of any Defense Department, the Secretary of the Department of Energy, and the chief officer of any other agency or unit officially designated as a "defense agency" and the Secretary of Commerce can promulgate separate rules, regulations and policy guidance regarding patents and patent applications.

The authority granted to DoD to use appropriated funds for the settlement of claims of patent infringement amply illustrates the point that the military agencies do, in fact, become involved in such cases through the performance of their procurement functions. The right to "reasonable compensation only" accorded the patent holder who brings suit against the U. S. Government is again a recognition of that fact.

Unauthorized Patent Use by the Government

The judicial remedy available to a patent holder under Title 28 of the U.S. Code refers to unauthorized use of a patented in-

vention by the Government or by Government contractors. (Peters 1967) Section 1948, paragraph one reads in part:

> Whenever an invention...covered by a patent of the United States is used or manufactured by or for the United States without license of the owner thereof or lawful right to use or manufacture the same, the owner's remedy shall be by action against the United States in the Court of Claims for the recovery of his reasonable and entire compensation for such use and manufacture.

The second paragraph continues:

> for the purpose (of the first paragraph) of this section... use or manufacture for the United States is the use or manufacture of an invention...covered by a patent of the United States by a contractor or a subcontractor...for the Government and with the authorization or consent of the Government...

It is important to note that the Government and its contractors may not be prohibited from the use of a patented invention. By limiting a patent owner's remedies to those specified above, Title 28 subjects the patent(s) involved to compulsory licensing in favor of the United States Government. (Peters 1967) Consideration of the effect on contractor performance of unauthorized patent use is therefore not required of the contracting officer whose anticipated contract award may eventually lead to such a claim by a patent owner. More specifically, in developing his cost analysis, the principal contracting officer need not analyze the impact on final performance costs of a break in production forced by a patent owner requesting an injunction against continued work by the prime contractor or a subcontractor.

Eminent Domain

The judicial foundation of the right to immunity from a patent owner's suit to enjoin work being performed by or for the government

may best be summarized as follows:

> ...the right granted the Government under 28 U.S.C. 1948 is one of eminent domain, i.e., Congress has taken away the patent owner's right of injunctive relief, providing instead a right of reasonable and entire compensation for the taking. It may be helpful to point out that the remedy available to a patent owner...is for unauthorized use by or for the Government of a patented invention, and not for patent infringement. (Peters 1967)

The distinction between "unauthorized use" on the part of the Government and "patent infringement" by private parties is an important one. The patent owner's remedy in the former case is limited to "reasonable and entire compensation", while in the latter instance the possible remedies may include a combination of injunction, damages, courts costs, and attorney fees. The reason for this difference lies in the government's vested right to use the patented invention (for the common good), while, in the case of private parties, no right to use the patented invention of another exists without a licensing agreement. (Peters 1967)

DoD PATENT REGULATIONS

In view of the foregoing discussion of the Government's rights regarding unauthorized use of patents, some evidence of the recognition of this factor in DoD procurements is required. The following overview of patent clauses to be included in all DoD contracts follows the format in Section 9 of the Defense Acquisition Regulation (DAR).

Authorization and Consent

The concept of authorization and consent is used to prevent any interruption of contractor performance in government work.

In contracts for supplies and services the following clause (unedited) is inserted:

> The Government hereby gives its authorization and consent (without prejudice to any rights of indemnification) for all use and manufacture, in the performance of this contract or any part hereof or any amendment hereto or any subcontract hereunder (including any lower-tier subcontract), of any invention described in and covered by a patent of the United States...the use of which necessarily results from compliance by the Contractor or the using subcontractor with (a) specifications...or (b) specific written instructions given by the Contracting Officer directing the manner of performance. The entire liability to the Government for infringement...shall be determined solely by the provisions of the indemnity clauses...and the Government assumes liability for all other infringement to the extent of the authorization and consent herein granted. (DAR 9-104)

The government does not assume full responsibility for all liability for all possible damages due the patent owner. Such an agreement to indemnify the contractor against liability for a patent infringement is expressly prohibited.

Patent Indemnification of the Government by the Contractor

Patent indemnity clauses are used to provide for reimbursing the Government for patent infringement liability in formally advertised contracts in excess of $10,000 for supplies or construction. The basis for determining if an indemnity clause is required involves the nature of the supplies; that is, whether they are normally sold or offered for sale to the general public (with minor modifications). (DAR 9-103) If that is the case, infringement of a patent becomes the sole responsibility of the contractor with regard to damages due the patent owner. The government is responsible for notifying the contractor of any suit filed by the patent owner, and permitting the contractor sufficient opportunity to prepare and participate in defending the suit.

The reasoning behind this requirement closely parallels the criteria used in judging if a contractor's claim for exemption from the requirement to furnish cost or pricing data for an item whose price is (or is based on) an established catalog price. (ASPM no. 1 1975) If the construction performed or supplies furnished under the contract are sold (or have been sold) to the general public, then the government is buying what is essentially a commercial product. Infringement of a patent in the performance of a contract for such a product then is due entirely to the contractor's own actions for which he is properly liable.

Notice and Assistance

The contractor is required to notify the Government of all claims for patent infringement resulting from performance of a Government contract. (DAR 9-104) In addition, the contractor must assist the Government by providing evidence and information in his possession, in connection with any suit or claim of alleged patent or copy right infringement made against the Government. This requirement applies to all contracts over $10,000 for supplies, services, research and development, or experimental work, and construction.

Administrative Claims

A claim for compensation against the United States by reason of patent infringement under any of the applicable statutes must be submitted in writing to and received by a department, agency, organization, office or field establishment within the Department of Defense. Claims generally should include the following data:

(DAR 9-404)

1. An allegation of infringement;

2. A request for compensation, either expressed or implied;

3. A citation of the patent(s) alleged to be infringed;

4. Designation of the alleged infringing item or process sufficient to permit identification;

5. Designation of a minimum of one claim for each patent allegedly infringed;

6. Or, in lieu of items 4 and 5 above, certification that an attempt was made by the claimant to determine the item or process which is alleged to infringe, but that he was unable to do so. Reasons must be provided establishing the basis for his belief that his patent(s) is being infringed.

Any Department which receives an allegation of patent infringement must acknowledge the claim and supply copies of the same to other interested Departments. In the case of a Navy contract, the Office of Naval Research has overall authority for processing administrative claims of alleged patent infringement. In addition, major systems commands also have a patent counsel with limited authority to settle administrative claims up to $5 million in value. (NAVAIRSYSCOM)

On the average the Navy has approximately sixty adminstrative claims in process. When notified of receipt of a patent infringement claim, the major systems commands will normally assume responsibility for final settlement of the claim from the claimant. Naval Air Systems Command, by virtue of the highly technical nature of its procurements, is involved with one-half of the total number of claims of alleged patent infringement filed against the Department of the Navy. The majority of claims are instituted by firms in the electronics industry, due primarily to the competitive nature of the market. This competitive environment has also encouraged the

concentrated use of patent protection for the developing technology.

The majority of patent infringement claims are the result of what may best be described as insufficient patent coverage investigation on the part of contractors or subcontractors performing work under NAVAIR contracts. Claims generally arise because a contractor either knows of no patent on the item or process, or fails to recognize the possibility that patent coverage may be involved.

The dollar value of compensation requested in an alleged patent infringement claim is dependent on the size of the procurement involved. In processing each claim, the patent counsel applies the concept of "reasonable compensation" to determine the value of the settlement to be offered. The average settlement is approximately $100,000. The willingness of the claimant to accept administrative settlement reflects the uncertainty of and great expense involved with the judicial process of patent infringement suit in the Court of Claims. Such legal action routinely requires more than two years from initiation of the suit to first hearing by the court. A final ruling will often not be rendered for many years; therefore, claims handled in this way involve a large investment in legal fees. In the end, a claimant's decision to sue the government must include an assessment of the dollar value of the compensation claimed and the likelihood that the claim will be upheld by the Court. A 1978 Court of Claims decision in favor of the Auto-Gyro Company of America resulted in an award of $14 million signifying the size of the reward which may accrue to the

successful patent owner. That suit was in litigation for many years, and the size of damages awarded to the claimant included more than $8 million as compensation for the length of time involved. Currently, twenty suits alleging patent infringement remain pending in the Court of Claims.

ROYALTY COSTS

Royalties are defined as "any costs or charges in the nature of royalties, license fees, patent or license amortization costs, or the like, for the use of or rights in patents or patent applications". (ASPM no.1 1975) The Armed Services Procurement Regulation Manual for Contract Pricing on DD Form 633, Contract Pricing Proposal, describes the type of information required in a contractor's estimate of royalty costs in a negotiated procurement: (ASPM no. 1 1975)

> If the total cost entered here is in excess of $250, provide ...the following information on each separate item of royalty or license fee; name and address of licensor; date of license agreement; patent numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.

Royalty payments normally result from license agreements for the use of patented products or manufacturing processes. The license agreement must explicitly describe the item(s) it covers on the contract under negotiation. If the license agreement is not sufficiently definitive, the above information in the footnote is not considered adequate cost or pricing data. (ASPM no. 1 1975)

Evaluating Royalty Costs

Royalty information is required to be submitted only in negotiated procurements. The cost(s) of patent use is thus involved in the complete analysis of all contract costs. Evaluation of these items by the contracting officer requires a determination that the royalties are not excessive, improper, or inconsistent with any rights the Government may already own or has acquired in particular inventions, patents, or patent applications. The contracting officer is also required to forward all royalty information to the patent office within the procuring agency. That office advises the contracting officer of the appropriate action to take.

Patents Held by the Government

The above stipulation that royalty determinations be made by the office (or legal counsel) responsible for patent affairs within the agency is closely related to the government's vested interest in research and development efforts. The Commission on Government Procurement stated in 1972:

> The Government invests some $15 billion per year in research and development programs. A great deal of this is carried on under contracts or grants. During the course of such programs, some 9,000 inventions per year are made by contractors or grantees. This activity has necessitated the development of policies respecting the disposition of rights in such inventions. Should the Government take all rights to an invention arising under its contracts? (Report of the Commission on Government Procurement 1972)

This question illustrates the fact that the Government, in the course of its yearly investment in R&D work, avails itself of the opportunity to patent thousands of new inventions.

This knowledge is the focal point upon which most controversy regarding Federal patent policy reform centers.

Whether the Government should exercise its patent rights on inventions discovered in the course of contract performance is not, however, within the scope of this paper to consider. It is presented to illustrate the point that examination of proposed royalty costs requires careful analysis of license agreements to ensure that the Government does not own the patent rights concerned.

CONCLUSIONS AND RECOMMENDATIONS

The objective of the Government in procurement is to acquire a quality product, in the time allowed, for a fair and reasonable price.

The objective of the exercise of the Government's power to issue patents is to encourage invention and innovation by granting exclusive rights to the inventor. In today's industrial environment technological advancement may be considered a prerequisite for maintaining a firm's competitive position in the market. Patent coverage can provide protection for valuable breakthroughs in any industry.

Are the two above-mentioned objectives mutually exclusive? In the day-to-day process of acquiring goods and services from private industry, the Government must face this question. Resolution of the conflict lies at the basis of both activities: each is carried out to promote the public welfare. Benefits accrue in each case, but the recipient is not the Government.

In both situations, the country as a whole is rewarded.

As stated at the beginning of this paper, patent infringement in Government contracts is the area of study. The Federal statutes regarding patent infringement, or what is more appropriately described as unauthorized use of a patent by the Government, are most equitable in protecting the rights of the patent owner. The primary thrust of the statutes with respect to Government contracts is to avoid any injunctive recourse that would interfere with contractor performance. Adequate recourse in the form of administrative claims or judicial proceedings via the Court of Claims is available to patent owners alleging infringement.

Relating patent infringement as a cost element to be considered in contract pricing and negotiation is, at best, an impossible task. The ability of military agencies to settle patent infringement cases through administrative claims affects appropriated funds within the agency, but in no way impacts on the contract involved. The contracting officer's sole concern with patents is royalty costs. As was shown, the responsibility for this evaluation has been delegated to the legal departments.

One recommendation, that of extending authority to settle administrative claims of patent infringement to all Government agencies, is presented. This view was profered by the Commission on Government Procurement in 1972, but has not yet been enacted into legislation. The utility of the authority is fully recognized as providing a timely, low cost method for patent owners

to recover alleged damages against the Government. Its extension to other than military agencies is worthy of renewed attention in Congress.

Last, it is highly recommended that students who display dissatisfaction with the Government's unauthorized use of patents be provided a copy of this paper in hopes of assuaging their concerns without resorting to formal research.

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Zero-Base Budgeting and the Federal Experience

by

Lieutenant R. A. Neidrauer, USN

ABSTRACT

A condensed history of ZBB in the public sector. The author defines ZBB from several perspectives and demonstrates the theoretical process required to implement such a program. The realities of political and organizational considerations are presented as impediments to successful prosecution of the theoretical process. The author concludes the paper by providing some historical statistics relative to the ZBB experience in the Federal Government.

This paper was submitted to Professor John D. Senger as partial fulfillment of the course requirements for MN 3105 (Organizational Systems II).

Lieutenant Neidrauer received his Bachelor of Science Degree in Education from Buffalo State College in 1971. He is a candidate for the Master of Science Degree in Computer Systems Management at the Naval Postgraduate School.

INTRODUCTION

In November, 1970, a relatively unknown state senator and erstwhile peanut farmer from southern Georgia, who had been recently elected to the governorship of that state on a platform that promised to reorganize Georgia's executive branch and make state government more efficient, read an article in the Harvard Business Review by Peter Phyrr, the Manager, Staff Control at Texas Instruments Corporation in Dallas Texas. The article, titled "Zero-Base Budgeting", described a budgeting procedure based on cost/benefit techniques that enabled TI to more effectively allocate limited resources to operations of an "optional or discretionary character". (Phyrr 1970)

Impressed by the soundness of the techniques described in the article, the governor hired Mr. Phyrr as a consultant to the state and implemented ZBB in the state budgetary development procedures. Six years later, this relatively unknown southern governor had been elected President of the United States.

That former governor and President-elect, James Earl Carter, announced that "Immediately after my inauguration, I will require zero-base budgeting for all federal departments, bureaus, and boards by executive order". (Carter 1977) Based on what he perceived as the successful implementation of zero-base budgeting in Georgia, a process that "resulted in a fifty percent reduction in administrative costs", he had decided to revamp the method by which the Federal budget was prepared. (Carter 1977)

The purpose of this paper is two-fold. The first purpose

is to examine the theory and practices of zero-base budgeting. The second purpose is to review how successful this technique was when it was implemented on the federal level.

WHAT IS ZBB?

Zero-base budgeting has been defined as "an operating, planning and budgeting process which requires each manager to justify his entire budget from scratch (hence zero-base) and shifts the burden of proof to each manager to justify why he should spend any money at all. This approach requires that all activities be identifed in 'decision packages' which will be evaluated by systematic analysis and ranked in order of importance". (Phyrr 1972)

In order to understand ZBB and why it evolved, it is necessary to understand the traditional planning and budgeting approach; i.e., its underlying assumptions and shortcomings.

Budgeting in the traditional manner essentially calls for three steps:

1. Taking the last year's spending level, and allowing for inflation, extrapolate that figure into next year's budget.

2. Increment that trended level for wage and salary increases as well as increases in the cost of required materials and services.

3. Further increment that trended spending level to allow for new projects and programs. "Such requests often represent 50 to 100 percent increases over the incremented trend." (Cheek 1977)

Inherent in the traditional approach are several underlying assumptions. First, it is assumed that all of the activities that were included in the last year's spending level were essential to achieving the on-going objectives of the organization. It also assumes that those objectives are still applicable and are more urgent than newly requested programs. Furthermore, it assumes that the activities funded last year are the most cost-effective and efficient way to accomplish the organization's objectives. Last, the traditional method of budgeting assumes that the activities will continue to be cost-effective and necessary in the coming year, thus requiring increases only for labor and materials inflation. As Cheek points out, "unless all of these assumptions are true - and it is highly unlikely that they are - our simplistic extrapolation has generated a grossly inflated budget". (Cheek 1977)

The results of the traditional approach are that when the consolidated figures are presented to top management for review, the figures are presented in a way as to tell top management exactly how much they are spending, but very little about what they are getting for the money. Further, while knowing how much is being spent for a particular activity, there is no way of deriving from the budget if this expenditure is the best way to achieve the organizational objectives. Since, in any organization, there is a finite limit to how much money is available, it is the responsibility of top management to allocate the limited resources in the most effective manner.

Yet, in the traditional budget, there is almost none of the information required to make a rational decision on where to reduce or eliminate ineffective programs.

While ZBB is a relatively recent addition to management techniques, the concept is not entirely new. In the early sixties, the U. S. Department of Agriculture began using a "ground-up" budgeting technique which included a re-evaluation of all the Department's programs annually. Later, during the Johnson Administration, the PPBS (Planning-Programming-Budgeting System) was introduced. It was a system that tried to assign costs to specific programs versus the assignment of costs to an agency or department. It attempted to specify basic objectives in each major area of activity and introduced cost/benefit (results) analysis as a means of justification for funding. "In sum, PPBS was a program-oriented technique with a long-range horizon that demanded cost justification of several alternative approaches against an established strategic need. Its primary thrust was toward planning, not budgeting. But where properly conducted, an operating budget was its natural fallout." (Cheek 1977)

ZBB, on the other hand, is primarily directed at the budgetary process. The three basic elements of zero-base budgeting are:

1. Identify the organization structure, "decision units", and objectives.

2. Develop "decision packages".

3. Rank the various "decision packages" at the next higher level of management to determine the relative priorities for funding.

In the final analysis, zero-base budgeting is a management information system that "provides management with an operating tool to evaluate and allocate its resources effectively". (Phyrr 1970)

IDENTIFY THE ORGANIZATIONAL STRUCTURE, "DECISION UNITS" AND OBJECTIVES

In this area ZBB "borrows" a number of concepts that evolved out of Management by Objectives. The company, at the top management level, must first decide what are the broad, long-range goals of the organization. These broad goals are then made known to the lower level managers whose task it is to plan their operations in such a manner as to most effectively and efficiently achieve the goals. In the development of the objectives, which must be specific, measurable and time-oriented, ZBB like MBO, calls for a participatory management system where the various levels of management decide together what the objectives will be. While in the business community there is some disagreement as to how much top management should be involved in the setting of specific objectives, the Federal Government is fairly explicit. "Congress is responsible for setting of broad goals, or missions, by statute. Long range goals in support of these missions are established by the planning process of the various agencies and departments. These long range goals are then identified to the lower level managers for incorporation into specific objectives". (Sarant 1978) Furthermore, as objectives are identified, managers must "simultaneously

determine the key indicators by which efficiency and effective performance are to be measured". (Sarant 1978)

A decision unit is the organizational entity which will be responsible for the preparation of budget requests. Selection of these units is based on the relationship of that entity to the entire organization. In order to avoid an excessive amount of time and paperwork, two often-voiced criticisms of ZBB, two important factors must be considered:

1. The units must not be so low in the organization as to preclude meaningful review or analysis.

2. The level decided upon for initiation of the budgetary process must be such that the managers of these units must be able to make "significant decisions on the amount of spending and scope, direction, and quality of work to be performed". (OMB Bulletin 1977)

The reasons for these guidelines are obvious. The simplest way to establish the decision unit is to do so at the cost center level, which is what Phyrr did at Texas Instruments. However, in a large organization such as General Motors, there can be literally thousands of cost centers which are identifiable. Further, the managers of these cost centers may have little or no control over the costs incurred. For example, the manager responsible for deciding whether to include expenses incurred as a result of warranty work done on a General Motors automobile in Iowa has no control on the warranty program as defined by GM. Since he has no control, it would be senseless to hold him accountable for the expenses that result.

Also, if the decision units are at too low a level, the time and effort put into the preparation and evaluation of the decision package may be such as to make the entire process too cumbersome and impractical to use in developing the budget.

DEVELOPMENT OF DECISION PACKAGES

Phyrr has defined two basic types of decision packages. One is the "mutually exclusive package which identifies alternative means for performing the same function". (Phyrr 1970) The best alternative is chosen and the other packages are discarded. The other type of package is the "Incremental package which reflects different levels of effort that may be expended on a specific function. One package, the 'base package' may establish a minimum level of activity and the others identify higher activity or cost levels". (Phyrr 1970)

To aid the manager in determining the requirements or objectives, top management should issue a formalized set of assumptions as to planned activity levels, projected wage/salary increases, etc. In addition to providing the manager with a basis for estimating funding requirements, Phyrr points out three other advantages for the formalized assumptions:

1. It will correct inaccurate assumptions or misunderstandings among lower level management.

2. It will provide a focal point for reviewing and revising assumptions and reduce the number of revisions.

3. It helps everyone keep track of the revisions to the list of assumptions and changes in activity levels and the costs that these revisions entail.

Each decision package identifies the reasons for performing an activity, the consequences of not performing the activity, measures of performance, alternative ways to accomplish the activity, and the costs associated with each of the alternatives. "The key to the zero-base budgeting process lies in the identification and evaluation of alternatives for each activity. (Austin 1977)

The first step in developing a decision package is to decide whether the activity performed by the decision unit will be continued, eliminated, or changed and what effect that decision will have on the accomplishment of the organization's objectives.

Once that decision has been made, the next step is to develop alternative means to achieve the desired result. Then it must be determined at what level below which the result can not be accomplished, i.e. establish the "zero-base" of the activity.

Once the minimum level has been established, the manager then develops packages that show how a greater level of expenditure provides greater amounts of the desired results that achieve the desired objective.

THE RANKING PROCESS

In theory, once the decision unit managers have developed their decision packages, one ranking of all of the packages could be performed by top management. However, as Phyrr points out this single ranking would impose a "ponderous, if not impossible task on top management". (Phyrr 1970) On the other hand, allowing ranking only at the decision unit level would not give top management the flexibility it needed to examine

possible trade-offs and reprioritization.

To control the volume of packages that each consolidation level of management must review, Phyrr recommends setting "cut-off" levels. At each level, management would review the ranked packages from the next lowest level, and merely skim the top rated packages until the required expenditure for these packages reached a predetermined percentage of the previous year's expenditures. For example, at the top level of consolidation, the cut-off may be at eighty percent of last year's budget for reasonableness. The remaining twenty percent will then be "seriously scrutinized and rank the remaining low ranked and more discretionary packages into a consolidated package to be passed to the top". (Phyrr 1970) At each lower level a lower cut-off level would be established so that a thorough review of all packages would occur at some level.

The initial ranking should occur at the decision unit level where the manager evaluates the relative importance of his own packages for the various activities for which he is responsible.

Then the manager at the next level up the chain-of-command reviews the rankings of all of the packages from all of the decision unit managers who are responsible to him, and produces a consolidated ranking of all the packages for presentation to the next higher level.

Phyrr recommends that the consolidation process be done by a committee made up of the higher level manager and all subordinate managers whereby they vote on the relative priorities.

This depends on two things: First, it assumes that the higher level manager is willing to give up some of his control, and secondly, that all of the individuals will vote rationally and not make deals to ensure funding for their "pet" projects.

As Austin points out, ranking involves arranging the packages in priority order on the basis of cost/benefit analysis or subjective evaluation. "The ZBB process does not require the complete quantification of all costs and benefits. It gets away from this by using an ordinal ranking process." (Austin 1977) All that is needed to be known is that package "A" is better than package "B", not that "A" is four times better than "B".

BENEFITS AND LIMITATIONS OF ZBB

Proponents of ZBB claim the process benefits the organization in several ways. First it links results with allocations. ZBB forces a closer examination of assumptions related to allocation. ZBB forces the examination because it requires specific results to be stipulated before allocation is permitted.

ZBB also fosters committment and creativity because it requires the manager to state what he will achieve, and what resources he will need to achieve it. As Austin points out, the manager "is not likely to forget that he developed the objectives and he won the resources to achieve them as he works towards the results he said he could attain". (Austin 1977)

ZBB also improves the feedback on decisions. In seeing how their packages were ranked, the managers gain an insight of the factors influencing allocation decisions.

Proponents also claim that ZBB improves the quality of planning in that it gives managers a better understanding of the goals of the organization and how to apply the budget accordingly, as well as permitting the shifting of resources to higher benefit options.

Furthermore, ZBB helps the organizing function by clarifying and defining resource responsibility. It eliminates duplication of efforts and overlapping responsibility and authority. It is also useful in developing and training managers by helping managers to "better understand their jobs and how their roles can help accomplish organizational goals", as well as giving managers a better understanding of budget and planning processes and increased involvement of personnel at the activity level. (Austin 1977)

The detractors claim that ZBB requires a lot of time, money, and paperwork to produce a budget that may not meet the desired objectives.

A danger in installing a zero-base budgeting process is that "it implies that the budgeting techniques being replaced are inadequate". (Brown and Suver 1977) It implies that the managers have not done enough evaluation and planning in the past. This implication might well lead to resentment by the managers toward the ZBB system being installed, and to attempts to thwart the system.

Critics also contend that ZBB has not significantly effected the allocation of funds. In a survey of the department heads and

budget analysts in the state of Georgia by George S. Minmer and Roger H. Hermanson, done in 1972 after ZBB had been installed, only seven percent of those surveyed indicated that even a slight shifting of financial resources had occurred. The early U. S. Department of Agriculture attempt mentioned previously resulted only in "identifying an excess expenditure for files, and a $10,000 reduction (out of a multibillion dollar budget) in an obsolete research program". (Brown and Suver 1977) Furthermore, the single most low ranked program was the subsidy to the 4-H program. Yet, due to a fear of possible political reaction, the program was fully funded.

Another criticism offered is in the ranking process. In addition to the burden of reviewing thousands of decision packages, the use of the cutoff percentages allows lower level managers to hide inefficiencies, make trade-offs with other managers to protect pet projects, and "label featherbedding items as essential" in order to avoid higher level scrutiny. (Brown and Suver 1977) This, of course, defeats the entire purpose of the system.

In the final analysis, there has not been a great deal of empirical evidence to support either the proponents or critics of ZBB. In a survey of 481 enterprises that have either been using zero-base budgeting techniques, or has attended ZBB seminars conducted by the American Management Association, several conclusions can be drawn. Of the respondents who had implemented ZBB, five main objectives were given as to why they chose ZBB:

1. To better allocate resources.
2. To improve decision making.
3. To facilitate planning.
4. To reduce costs/personnel.
5. To reorganize the company.

Ninety-four percent of the respondents reported that their objectives were fully to fairly well satisfied; only six percent reported that they were poorly or not achieved at all. The objectives that were best achieved were to facilitate planning, to improve decision making, and to better allocate resources.

On the other hand, the survey conducted by Minmer and Hermanson in Georgia, showed that only seven percent of the respondents felt that the system effected the allocation of resources. Furthermore, seventy-seven percent felt the quality of management information received, used to facilitate planning, and improve decision making, either remained the same as before or only slightly improved.

While some of the contradictions may be explained by the fact that one survey was of businesses and the other of a government, and that the survey of Georgia State Officials was related to only one installation whereas Austin's survey encompassed many different adaptations, I believe that it is simply too soon to make a final judgement and that further empirical research is necessary before drawing any conclusions.

ZBB AND THE FEDERAL EXPERIENCE

True to his pre-inauguration promise, on February 14, 1977, President Carter issued a memorandum to the heads of all executive departments and agencies that ordered each agency and department to "develop a zero-base system within your agency in accordance with instructions to be issued by the Office of Management and Budget. The Fiscal Year 1979 budget will be prepared using this system". (Carter 1977) This memorandum was followed by OMB Bulletin 77-9, issued on April 19, 1977, which gave detailed instrucitons on how to implement this new process. Additionally, a year earlier, in February, 1976, Senator Edmund Muskie, and others introduced the "Government Economy and Spending Reform Act of 1976" which would have made zero-base budgeting mandatory for all federal agencies as well as establish a program of quadrennial review, and evaluation of all federal programs by Congress to determine if the merits and results of a program warranted its continuation.

How well did ZBB work in controlling the costs and improving the efficiency of the Federal Government?

The initial reaction to the program was an outcry from the various agencies that bemoaned the inordinate amounts of time and paperwork required in accumulating the necessary cost data and preparing decision packages. Further, as Allen Schick pointed out in an article that reviewed the first year under ZBB, "No matter how thoroughly the program managers scoured their operations for savings, the year to year changes in the budget are driven by policies over which control can be secured through

non-budgetary actions. With ZBB upwards of seventy-five percent of the budget will continue to be uncontrollable under law. Upwards of ninety-five percent will continue to be defacto uncontrollable". (Schick 1978) By this, he means that most of the costs are incurred as a result of legislative action, and to curtail costs would require the repeal of the legislation. The problem with this as Congress is now learning under "Reagonomics" is that it may not be in their best political interest to cut a program that is beloved by their constituents regardless of its ranking among the decision packages.

By one measure, ZBB was a success. The system was installed and produced a budget on time: A budget that outwardly adhered to the guidelines presented by OMB. Schick claims that this occurred because "it did not really change the rules by which budgetary decisions are made. It changed the terminology, but little more". (Schick 1978) Agency after agency accomodated ZBB to its existing budgetary framework. If it had a program oriented budget, it selected programs as decision units. If its budget was still organizationally oriented, the organization became the decision unit.

OMB guidelines also caused the decision packages to be almost devoid of any real decisional use by limiting them to two pages per package, plus supplemental material in order to avoid the predicted paperwork deluge. This two page limit, however, "signalled agencies that they didn't have to stuff their packages with analytical material". (Schick 1978)

Also to help prevent the possibility of being overwhelmed by thousands of individual decision packages, OMB permitted agencies to consolidate decision packages that obliterated program identities and priorities of lower level managers. In doing so, OMB violated the basic concept of managerial involvement and committment in the budgetary process.

As a result, "the first president to promise a zero-base budget delivered the most incremental financial statement since Wildavsky cannonized that form of budget-making more than a dozen years ago". (Schick 1978) All but two percent of the forty billion dollars of increased spending was due to inflation and workload increases, and there was not one single major program that was significantly reduced or eliminated.

While the literature regarding Carter's attempt to implement ZBB in the federal budgetary process stops after the first budget, some conclusions can be reached. Succeeding budgets continued to increase without a notable reduction in established programs. After the initial uproar, very little has been said about the attempt to implement ZBB. Many of the hoped for benefits were lost in the attempt to adapt zero-base budgeting to an organization of almost uncontrollable proportions. The Muskie bill requiring zero-base budgeting in the federal government failed to gain the approval of Congress, perhaps due to the recognition of the political realities by his colleagues. As Robert Anthony points out, although zero-base budgeting as implemented by President Carter and OMB was a "fraud", and even though

the good points of ZBB are not new, budgeting people in the federal government should incorporate the good points of ZBB in order to improve the financial controls over government spending. (Austin 1977)

As to the final fate of ZBB in the federal government, although the phrase has passed out of usage, there are some benefits to be derived from the utilization of the ZBB concepts in making government more effective and efficient.

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Software Engineering and Project Management

by

Lieutenant Commander Dennis Egan, USN

ABSTRACT

The growing disparity between the state of computer hardware technology and computer software development is something referred to as the "software crisis". In this article, Lcdr Egan examines the software crisis and discusses the impact that the computer software problems can have on weapon system programs. He also discusses software engineering techniques, and makes a number of recommendations for improving software program management.

This paper was submitted to Professor David V. Lamm, CDR, SC, USN, in partial fulfillment of the course requirements for MN-3301 (Introduction to Systems Acquisition and Project Management).

Lcdr Dennis Egan, USN, received his Bachelor of Arts Degree from Rutgers University in 1969. He was awarded the Master of Science Degree in Management Science at the Naval Postgraduate School in June 1981.

Captain P. M. Ace has some problems. As the Project Manager for development and introduction of a new shipboard weapons control system, he has seen this complex program through most of the major hurdles in the acquisition process. Now in the full-scale development phase, he has been confronted with continual schedule slippages. There has been no single major delay, but the number of smaller slips are starting to add up. The competitive operational evaluation between the two alternative designs is scheduled to end in less than six months. This date appears to be unattainable at this point, and his current task is to prepare the necessary reports to his superiors informing them of the anticipated schedule slippage.

In briefings and strategy meetings with his acquisition team and two weapon system contractors, Captain Ace has become aware of a single thread in each of the schedule delay situations - software modifications. A competent technician, Captain Ace is aware that both systems depend in large part on a complex computer program for their hardware coordination and performance interfacing. The contractors are depending on the system software to provide the hands-off detection and tracking and assignment of various weapons systems. Both software systems also include frequent operator prompting, numerous system alerts, self-diagnostic, and degraded capacity routines which were designed to meet the required operational simplicity and reliability standards specified.

Captain Ace also has on his desk a recent letter from the

in-service monitor of the systems' software documentation and maintainability. The letter reported a significant downturn in performance in the documentation area, apparently due to the spate of software modifications made under schedule pressure.

An important acquisition project was now seriously ill, and Captain Ace was of the opinion that the disease might prove fatal.

Captain Ace's project is suffering from symptoms of what has been called a software crisis. This crisis, first identified formally in 1973, involves the growing disparity between the rapid pace of hardware design refinement and production technology. (Boehm 1973) Also included in this is the stagnated level of software production technology. Computer hardware cost and size have steadily decreased in the past twenty-five years. "The unit cost of memory and storage has been reduced at a compounded annual rate of 40%" over that period. (Jensen and Tonies 1979) Computing devices which filled entire floors of users' work space can now be replaced with desk top units of equal capacity. In addition to the replacement of older equipment, the hardware explosion has brought computers within reach of an incredibly diverse market of new, first time users. Applications as awesome as space exploration and as mundane as control of home washing machines now utilize the products of today's hardware technology.

For the weapon system designer, an entire new level of sophistication in weapon systems is now possible. The slowest and often most unreliable link in the control and coordination

of weapon systems - human operators - can now be efficiently replaced, in many cases, by high speed, highly capable micro-processors. These tiny computers can be used in the weapon system control equipment, and owing to the miniature size, even in the weapon itself. "These features have contributed to the achievement of DoD systems with greater performance, capability, and flexibility." (Patterson 1977)

The hardware revolution has not been matched in other areas of computer systems technology. Even the most sophisticated of today's computers rely on human generated instructions, i.e. software, in order to perform even the simplest task. In an attempt to make this software production process more efficient, in hope that such efforts can increase the currently low output, various design and implementation techniques involve organizing the software package into modules which, within basic requirement specifications, can be developed by separate design teams, tested individually and then brought together. Using a sort of building block approach, different modules are integrated, tested, and then further integrated with additional modules. Figure 1 is a simplified illustration of this type of organization. Figure 1 is taken from Jensen and Tonies' Software Engineering, 1979. There are many variations on this basic methodology, and additional formally structured techniques which attempt to lend a sense of order and interrelationship to what is a complex seemingly amorphous task.

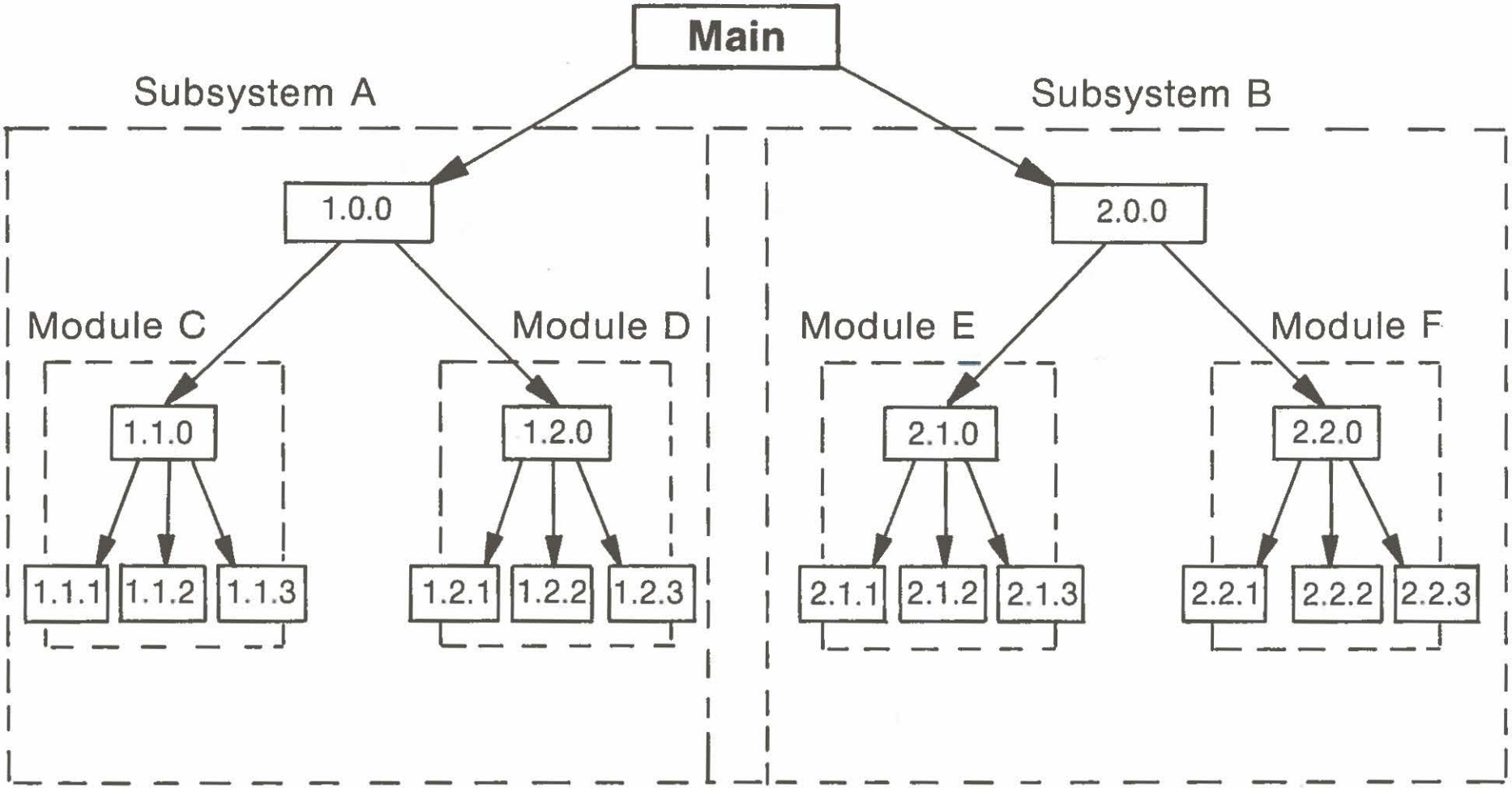
Main
Subsystem A
Subsystem B
1.0.0
2.0.0
Module C
Module D
Module E
Module F
1.1.0
1.2.0
2.1.0
2.2.0
1.1.1
1.1.2
1.1.3
1.2.1
1.2.2
1.2.3
2.1.1
2.1.2
2.1.3
2.2.1
2.2.2
2.2.3

Figure 1

The creative efforts of software development personnel are applied through all phases of the process. Some efforts such as actual coding of the software instructions can be extremely labor intensive, and require extensive and continuous quality assurance.

Despite the ever increasing application of software engineering concepts, the gap between hardware and software continues to widen. One reason has to do with the enormous increase in the complexity and size of software packages demanded. The easier access to computers has created a new generation of users, more sophisticated in their requirements, and eager to computerize more and more applications. "The increasing complexity of systems and application software has nearly overwhelmed us." (Jensen and Tonies 1979)

Seriously aggravating the entire software industry problem is a shortage of talented programmers. "The demand for computer programmers already outstrips supply by at least 50,000, and that gap is likely to widen. Barring major changes in software technology, the need for programmers could reach 1.5 million by 1990, more than triple the number working today." (Business Week, Sept. 1980) Software developers have two choices: pay greatly elevated salaries to acquire and retain programming talent, or accept less quality at lower salaries, and anticipate higher output error rates. Both choices have one thing in common -- increased costs, which are, of course, passed on to the product consumer.

For the computer purchaser, the bottom line is escalating software costs. Before the hardware breakthrough, "the concept of spending more on software than hardware was difficult to perceive for most managers and buyers". (Jensen and Tonies 1979) Yet, as figure 2, p. 81, shows, this has been the reality for more than a decade. (Boehm 1973)

As the nation's and perhaps the world's, largest sponsor of software development, the Department of Defense has a major concern in minimizing the effects of the software crisis. In 1976, DoD was spending over three billion dollars per year on defense systems software alone. The need to improve DoD management of software development was fully recognized by that time. (Symposium on Computer Software Engineering 1976)

There has been progress. Software engineering concepts have been accepted, and in some cases, mandated by DoD. (DoD Inst. 5000.29) Captain Ace and other program managers are made aware of standardization, configuration control, and documentation requirements for software development efforts under their purview. Captain Ace made it a point to acquaint himself with the various software design and development terminology when this topic was discussed in the training he received prior to taking over his current project.

The project acquisition strategy had provided for careful monitoring of contractor efforts in the area of software package documentation and life cycle maintainability criteria. All these areas are well referenced in various DoD publications and studies.

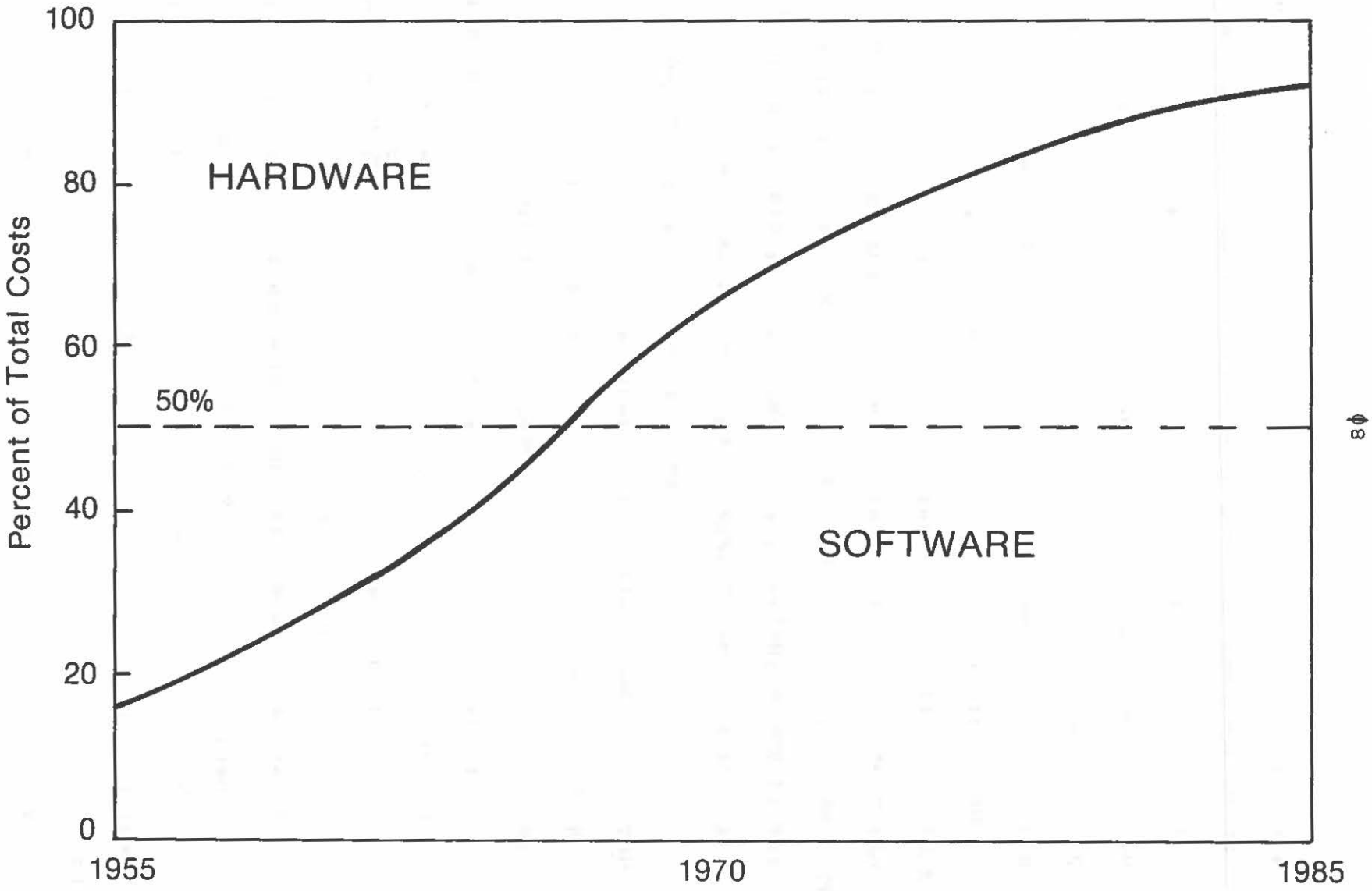
100
80
60
40
20
0
Percent of Total Costs
HARDWARE
50%
SOFTWARE
1955
1970
1985

Figure 2

While there has been some investigation of the integration of software systems into the total system configuration, within DoD, there is little to indicate an appreciation of or a concern for the unique aspects of software engineering methods and their potential impact on historical project management techniques. Figure 3. on page 83 is an excerpt from an Air Force study into the acquisition of embedded computer systems. While it does show some appreciation of the potential impact of a modularized organization approach to software development and design, it illustrates a less than complete understanding of the problem potential of this approach. Throughout the flow path shown, the presence of an iterative loop structure can be seen. This situation occurs when errors are discovered in the design or coding of a module, thereby requiring some correction of that portion of the module effected.

The structure shown assumes that errors discovered are of such a trivial nature that the basic module organization itself is not effected. Yet, one of the loops passes through an activity block labelled "Software Redesign". Given the type of activity blocks shown in the chart, it seems possible that errors could be detected which would require a major organizational redesign of the affected module. What if this module were number (1,0,0) shown in figure 1? The modules below (1,0,0) were designed and developed assuming a certain logical design of the module which would invoke their function. If a significant redesign of (1,0,0) was necessary, the effect of this effort on the functioning of all subordinate modules must be determined. If the problem with

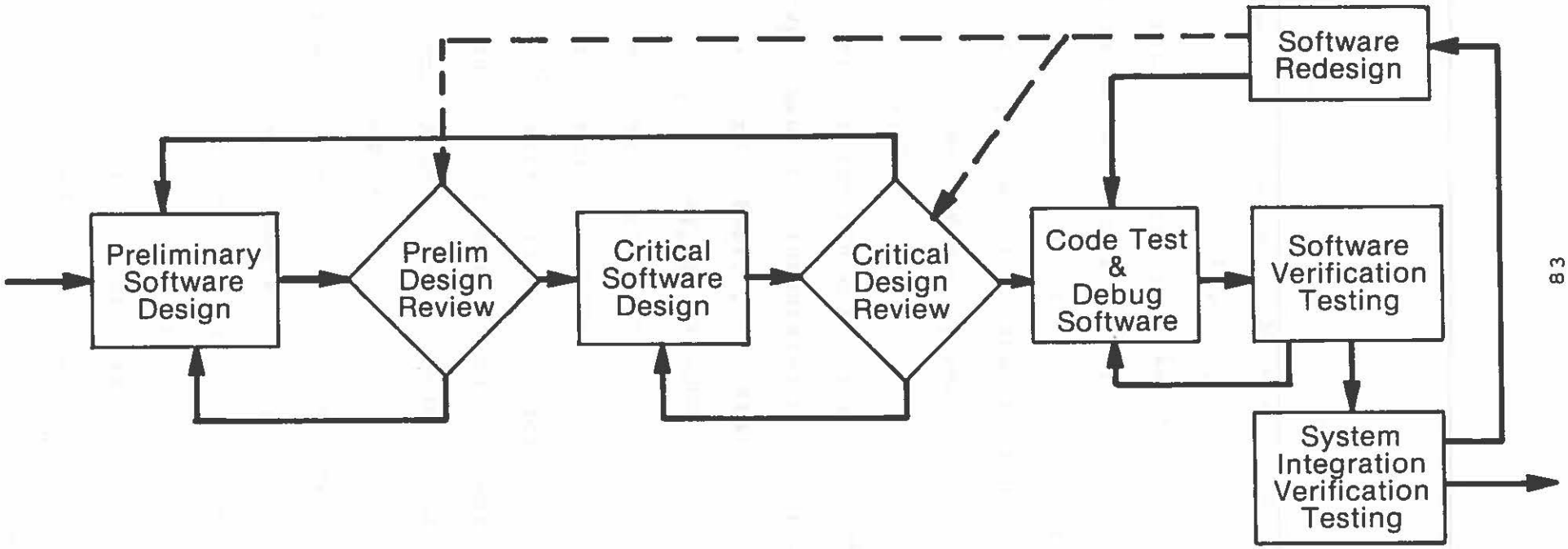

Figure 3 (Boehm 1973)

(1,0,0) developed during integration with module (MAIN), the previous integration testing between (1,0,0) and its subordinates would, at the least, require revalidation. It is conceivable that a complete redesign review of subsystem A might be required. The dotted lines in figure 3. have been added to indicate those additional impacts which the modular approach can have.

Did the formulation of test and evaluation schedules in Captain Ace's program take into account this looping schedule structure? Probably not! Most schedules, even those which use advanced techniques such as PERT and CPM, assume a generally horizontal, one direction flow. In addition, time line allocation within a schedule is normally based on the anticipated complexity of systems tests. The usual scenario, as applied to Captain Ace's project, called for separate, low density tests of individual warfare capabilities (ASW, AAW, ASUW) gradually moving to higher density, integrated tests of the entire system. The time line allocation would probably correspond to the test density and complexity.

Experience with software engineering techniques has shown error detection rates as illustrated by figure 4. p. 85 (Jensen and Tonies 1979) The type of errors detected first in each phase are of the type which prevent actual execution of the software module, and which most often will require the looping structure discussed earlier. In each phase of testing, some validation of results obtained in previous phases may be required. This situation does not support unmodified application of horizontal,

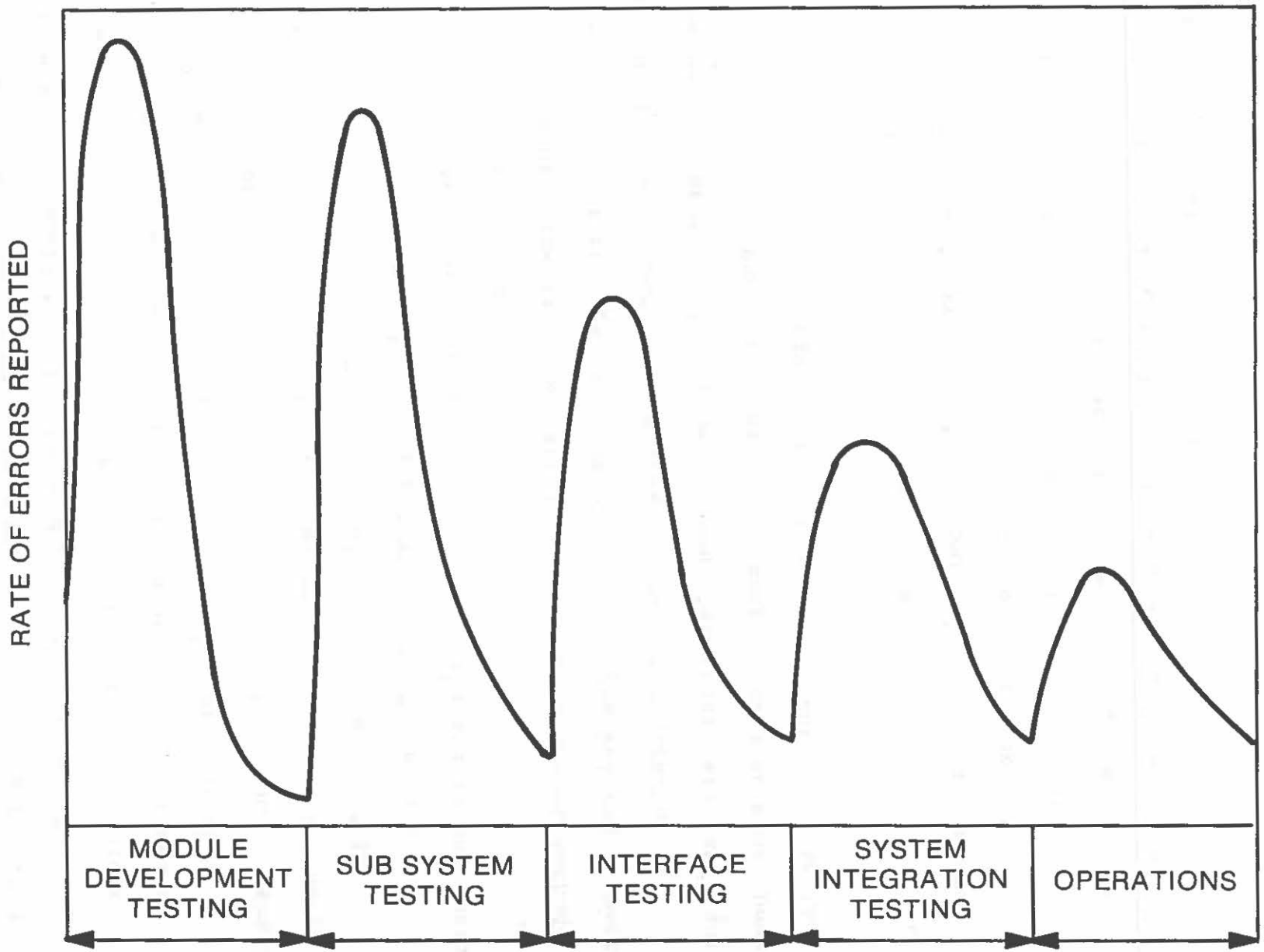
RATE OF ERRORS REPORTED
MODULE DEVELOPMENT TESTING
SUB SYSTEM TESTING
INTERFACE TESTING
SYSTEM INTEGRATION TESTING
OPERATIONS

Figure 4

one direction scheduling with time line allocation based on anticipated test complexity.

Can Captain Ace's program recover? The decisions required at this point would have little to do with the causes of the slippage, and are beyond the purpose of this paper. In order to prevent similar problems, project managers and their teams must be aware of their potential for an attack of "software crisis syndrome". To do this, it is essential that they determine the exact application of software engineering concepts in their program. This education must start with the issuance of the acquisition strategy and be an important part of contract proposal preparation and bid evaluation. The following recommendations are considered appropriate:

1. Request specific contractor software development methodology as part of the RFP/IFB. There are some general requirements already imposed by DoD in this area. Detailed contractor comments concerning software development techniques are important source selection considerations. No attempt should be made, however, to impose an absolute requirement for specific techniques in the RFP/IFB.

2. Request contractors provide initial estimates of software package size, and their estimated/historical programming productivity. This will provide an indication of a contractor's present ability to meet the contract requirements, given his current manning level. If large increases in programming personnel would be required subsequent to award, program output quality may be significantly affected.

3. Ensure schedulers reflect a detailed understanding of software engineering techniques in use. Updated output productivity and error rates are essential for efficient scheduling. Because programming is a people-based activity, correction of 1000 lines of program code, for example, will generate some number of new errors in the new code based on the coding error rate. In addition, the human nature of the process belies the inferential assumption that two programmers can code faster than one. Brook's Law is in effect: Adding manpower to an already late software project makes it later...more software projects have gone awry for lack of calendar time than from all other causes combined". (Brooks 1975)

It is not the purpose of this paper to discourage the use of software engineering in project acquisition. On the contrary, project managers and their projects can only benefit from its use. What is essential is that everyone involved know and understand how the game is being played.

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